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SOLDIER PERFORMANCE AND MOOD STATES FOLLOWING A STRENUOUS ROAD MARCH

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ABSTRACT

Eighty-nine soldiers performed a maximal effort 20 km road march, carrying a total load of 46 kg. Compared to pre-march values, post-march marksmanship accuracy decreased 26% for number of target hits and 33% for distance from the centroid of the target. Maximal grenade throw distance decreased 9%, but there was no change in maximal vertical jump height. The Profile of Mood States (POMS) questionnaire revealed an 82% increase in self-reported fatigue and 38% decrease in vigor. Significant decrements in some aspects of military performance occur when soldiers march rapidly with heavy loads over long distances.

INTRODUCTION

Road marching with loads is a fundamental task required of all soldiers, especially the infantryman (1). The modern day foot soldier carries almost twice the load of his counterparts prior to the 18th Century (2). Recent unpublished information indicates that soldiers participating in exercises at the Joint Readiness Training Center (Ft Chaffee, AR) carry an average total load of 40 kg, with maximal loads exceeding 60 kg. This is despite recommendations from the Infantry School (Ft Benning, GA) that approach march loads should not exceed 45% of body weight or 33 kg for the average soldier (3).

Soldiers required to road march with heavy loads may reduce their military effectiveness for a variety of reasons including decreased motivation, fatigue, and other psychological and physiological factors. The purpose of the present study was to examine soldier marksmanship, grenade throwing for distance, leg power and mood states following a strenuous 20 km road march.

METHODS

Subjects were 89 soldiers assigned to the 2nd battalion, 17th Infantry Regiment, 6th Infantry Division (Light), Ft Richardson, AK. Participants gave written informed consent following a detailed briefing on the purposes and risks of the study. On a subsample of these soldiers (N=55), pre-march body weights and heights were obtained and body fat was estimated from underwater weights (4).

Soldiers were given the mission to complete a 20 km road march as fast as possible. The march was an individual effort with each soldier charged to do his best. Rest breaks were allowed at the soldier's discretion.

Soldiers carried total loads of approximately 46 kg. Two pre-weighed sand bags of 14 and 18 kg were placed in the rucksack (3 kg) for a total rucksack load of 35 kg. The uniform, weapon (M-16), and helmet were estimated to weigh 5.0 kg (5). Load carrying equipment (LCE) had a mean (± SD) weight of 5.6 (± 2.0) kg.

The march was on flat roads with the exception of an area between 10 and 15 km which contained rolling hills. Soldiers could obtain food and water at 5 km checkpoints. The march ended at a small-arms range where finish times were recorded. Rucksacks and LCE were weighed to assure each soldier had carried the prescribed weight. Soldiers were asked to estimate their total number of rest stops and total time spent resting.

Pre-march values of marksmanship, vertical jumping ability, and grenade throw for distance were obtained 1-3 days prior to the road march. Post-march values were obtained immediately following the road march.

The marksmanship task was a "live fire" event. It was performed from the foxhole-supported position beginning within about 5 min of completing the road march. Soldiers fired 3 shots to confirm their weapon was zeroed. They then had 20 sec to fire 10 rounds, 2 at each of 5 identical silhouettes at a distance of

25 m. The number of silhouette hits and distance of each shot from the centroid of the silhouette was recorded.

Vertical jump ability (6) was measured immediately following the marksmanship task (about 10 min after the march). Soldiers jumped as high as possible and marked a board at the highest point of the jump. The highest of 3 trials was recorded.

Immediately after the vertical jump (about 15 min after the march) soldiers performed the grenade throw task. Soldiers threw simulated "pineapple" type grenades (0.5 kg) from a kneeling position with knees perpendicular to the direction of throw. Subjects were instructed to throw as far as possible with knees remaining on the ground. Distance was measured from the throw line to where the grenade first hit the ground. The longest of three trials was recorded.

Soldiers completed the Profile of Mood States (POMS) questionnaire (7) within 30 minutes of starting the road march and immediately following the post-march grenade throw. The POMS is a 65 item questionnaire which provides measures of six mood states. Soldiers scored each question on a 5 point scale ranging from 0 (not at all) to 4 (extremely). Soldiers were also interviewed after the road march regarding soreness, pain and discomfort in different body regions using a modification of the Corlett and Bishop (8) technique. Soldiers rated soreness, pain or discomfort in various body segments on a 6 point scale ranging from 1 (none) to 6 (severe).

RESULTS

Table 1 shows the physical characteristics on the subsample of the soldiers that were weighed and measured for body fat. The average(±SD) road march time was 314±70 min. The average(±SD) number of self-reported rest stops was 6.5±5.4 and the total self-reported rest time was 48.9±46.2 min.

Table 2 presents performance on the marksmanship task, vertical jump and grenade throw. Marksmanship performance declined following the road march. The number of hits decreased an average 26% and the distance from the centroid of the target increased an average 33%. Distance for throwing the grenade also decreased an average 9% following the march. Performance on the vertical jump did not change.

Table 3 shows the raw POMS scores and Figure 1 illustrates these values converted to T-scores. T-scores are soldiers' POMS scores compared to college norms with a score of 50 representing the average value for college students (7). Following the road march there were no changes in tension, depression, or confusion. There was a decline in vigor and fatigue increased considerably. Anger also tended to increase ($p=.07$).

Self-reported responses on the soreness, pain and discomfort questionnaire are shown in Table 4. Soldiers reported the highest levels of pain, soreness and discomfort in the feet. High scores were also reported for the upper torso region in the back of the body (neck, shoulders, upper and lower back).

DISCUSSION

The road march task was extremely strenuous. Following the march, fatigue was elevated 82% and vigor was decreased 38% as measured by the POMS. Thirteen soldiers (15%) sought medical attention either during the march or within 10 days after the march for march-related problems. Despite instructions to complete the march as fast as possible soldiers rested often, especially after the first hour. Many soldiers completed the march with great difficulty and were visibly exhausted by the effort. Thus, the post-march marksmanship and physical performance tasks were conducted under conditions of extreme physical fatigue.

Shooting accuracy degraded severely under these conditions. An increase in body tremors due to fatigue or elevated post exercise heart rate may account for the marksmanship decline. Whole-body sway while aiming a rifle is substantially increased even after a short period of exercise (9) and this may effect shooting accuracy. Muscle tremors increase after brief or prolonged muscular contractions (10, 11) and such tremors appear to be localized to the muscles involved in the contraction (11). In the present study the shoulder muscles supported much of the rucksack load and subjects reported high levels of pain, soreness and discomfort in this region. The shoulder supports the butt of the rifle during firing and if tremors were present here or in arms this would have a negative impact on marksmanship performance.

Another explanation for the degradation in marksmanship may be elevated post-march heart rates. Slight movements of the rifle may occur when the heart beats. Heart rates are elevated after exercise (12, 13) and the more intense the exercise, the greater the elevation (14). Reductions in heart rate through the use of beta-blockers can substantially improve shooting accuracy (15, 16).

The grenade throw and vertical jump tests were used to evaluate explosive strength or power (6, 17). Under the present conditions no decrements in vertical jump ability occurred. Activities like road marching that involve low aerobic exercise intensities do not appear to affect leg power. Patton et al. (18) found no decline in peak or mean power on the Wingate test when subjects performed a loaded road march task on a treadmill at <50% VO_2max. On the other hand, high intensity exercise like road racing significantly impairs maximal isokinetic strength of the legs (19, 20).

Post-march decrements in the grenade throw may be attributed to a nerve entrapment syndrome, and/or pain in the muscle groups used for this task. Compression of the brachial plexus by the shoulder straps of the rucksack may result in weakness, pain, paresthesia and numbness in the upper extremities (21, 22) and this may limit throwing ability. Legg and Mahanty (23) found that subjects carrying framed rucksacks reported discomfort mainly in the neck and shoulder region. In the present study the soreness, pain and discomfort questionnaires yielded some of the

highest scores in this same area. Several subjects complained that shoulder pain limited their grenade throwing ability.

Soldiers' pre-march POMS profile differed from college norms (7) and from the "iceberg" profile reported for runners (24, 25). Compared to college students (7) soldiers reported less tension, depression, fatigue and confusion but also less vigor and considerably more anger. A similar profile has been shown in field artillery soldiers prior to a field exercise (26).

Other investigations of acute changes in mood states following foot races (27, 28) have reported reductions in tension and vigor and elevations in fatigue. In the present study changes of similar magnitude were found for vigor and fatigue but tension was unchanged. Reduced post-race tension has been ascribed to a reduction in the uncertainty of the race and the athlete's anticipated performance or a reduction in state anxiety (28). While the requirements for this particular road march were slightly different from previous ones, most soldiers had performed road marches on other occasions and knew what to expect, possibly reducing their pre-march tension.

CONCLUSIONS

Soldiers displayed significant declines in marksmanship and grenade throwing distance following a 20 km road march in which they carried 46 kg. These performance decrements were accompanied by elevations in self-reported fatigue, decrements in vigor and increased soreness, pain and discomfort in the feet, shoulders and back. These results indicate that when soldiers perform a strenuous road march with a heavy load leaders can expect mood changes and decrements in essential soldier skills which may significantly impact military effectiveness.

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TABLE 1.

PHYSICAL CHARACTERISTICS OF A SUBSAMPLE OF THE SUBJECTS

MEASURE	N	MEAN	SD	MAX	MIN
AGE (yrs)	55	21	3	31	18
HEIGHT (cm)	55	177.9	6.4	197.6	162.9
WEIGHT (kg)	55	76.1	9.8	99.6	58.4
BODY FAT (%)	52	15.7	4.1	26.1	8.3

TABLE 2.

PERFORMANCE ON THE MARKSMANSHIP TEST,

VERTICAL JUMP AND GRENADE THROW

	PRE-MARCH		POST-MARCH			
MEASURE	M	SD	M	SD	T-Val	p
MARKSMANSHIP (hits)	7.3	2.6	5.4	2.7	4.86	<.001
MARKSMANSHIP (cm)*	28.8	13.8	38.3	14.2	4.77	<.001
VERTICAL JUMP (cm)	45.7	6.7	45.0	7.3	1.03	.307
GRENADE THROW (m)	27.7	4.3	25.1	4.5	7.67	<.001

*Distance from centroid of target

TABLE 3.

SCORES ON THE POMS QUESTIONNAIRE

	PRE-MARCH		POST-MARCH			
	M	SD	M	SD	t-Val	p
TENSION	12.2	6.0	11.3	6.2	0.52	0.606
DEPRESSION	11.2	9.6	11.5	10.0	0.28	0.785
ANGER	16.6	11.4	20.3	13.1	1.89	0.067
VIGOR	12.8	6.4	8.0	6.2	4.51	<0.001
FATIGUE	9.1	7.2	16.6	6.9	5.41	<0.001
CONFUSION	6.5	5.1	6.5	5.3	0.02	0.985

TABLE 4.

RESPONSES ON THE SORENESS, PAIN AND DISCOMFORT QUESTIONNAIRE

	MEAN	SD	MIN	MAX
FRONT OF BODY				
NECK	1.1	0.3	1	3
SHOULDERS	2.2	1.6	1	6
UPPER ARM	1.1	0.5	1	4
LOWER ARM	1.1	0.5	1	4
HAND	1.1	0.4	1	4
UPPER CHEST	1.2	0.5	1	4
MID TORSO	1.1	0.4	1	4
ABDOMEN	1.7	1.3	1	6
UPPER LEG	2.2	1.6	1	6
LOWER LEG	1.7	1.5	1	6
FOOT	4.7	1.6	1	6
BACK OF BODY				
NECK	2.5	1.6	1	6
SHOULDERS	3.5	1.7	1	6
UPPER ARM	1.1	0.4	1	4
LOWER ARM	1.1	0.5	1	5
HAND	1.1	0.4	1	4
UPPER BACK	2.2	1.6	1	6
LOWER BACK	2.6	1.7	1	6
BUTTOCK	2.0	1.6	1	6
UPPER LEG	1.7	1.3	1	6
LOWER LEG	2.1	1.6	1	6
FOOT	3.9	2.0	1	6

FIGURE LEGEND

Figure 1. Soldiers' Profile of Mood States Compared to College Norms. Vertical bars are standard errors.

DISCLAIMERS

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy or decision, unless so designated by other official documentation.

Human subjects participated in this study after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

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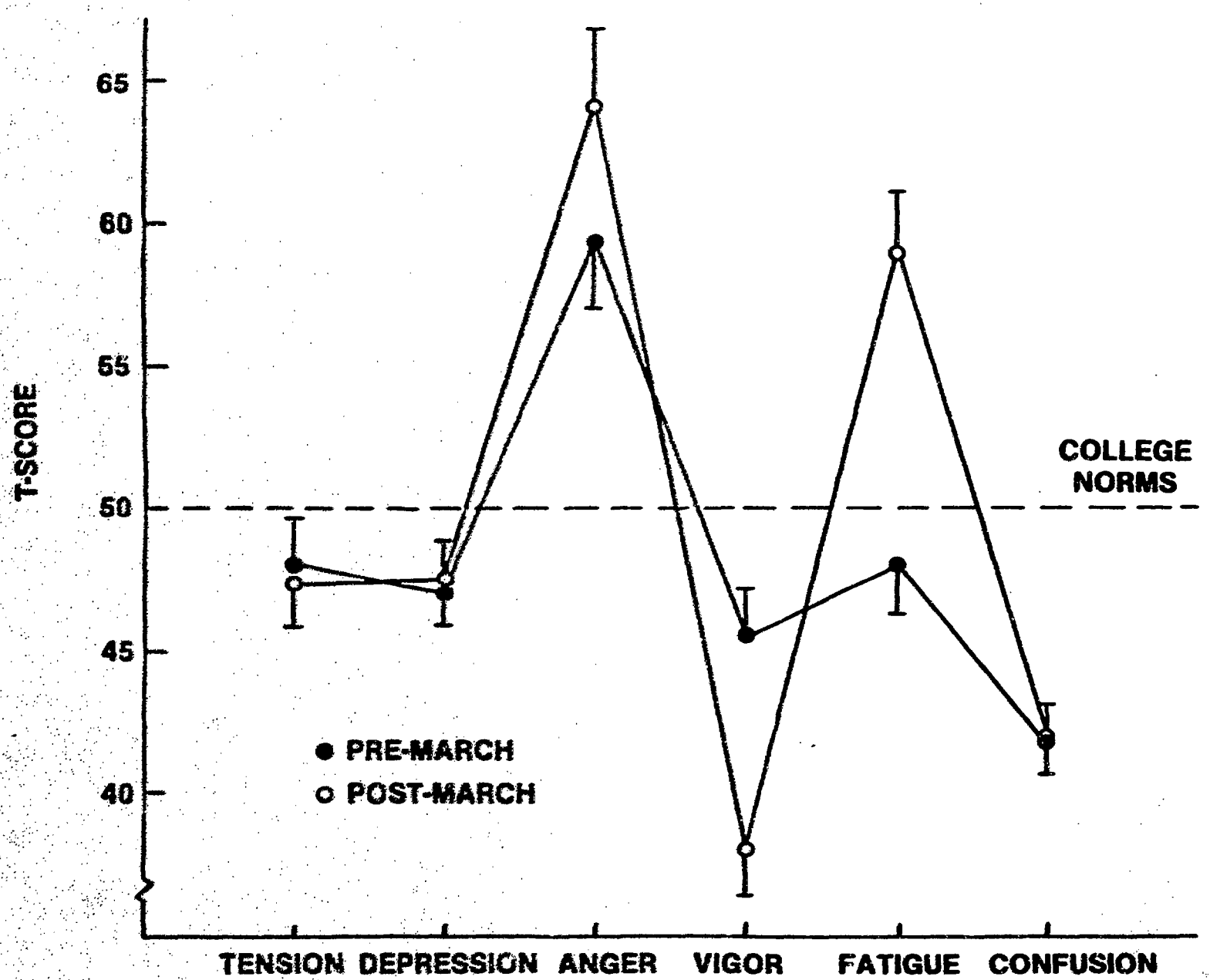
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